VARIABILITY OF OPTICAL PROPERTIES WITHIN THE LITTORAL ENVIRONMENT

J. Ronald V. Zaneveld
College of Oceanic and Atmospheric Sciences
Oregon State University
104 Ocean Admin.
Corvallis, OR 97331-5503
Phone: (541) 737-3571 fax: (541) 737-2064 email: zaneveld@oce.orst.edu
W. Scott Pegau
College of Oceanic and Atmospheric Sciences
Oregon State University
104 Ocean Admin.
Corvallis, OR 97331-5503
Phone: (541) 737-4635 fax: (541) 737-2064 email: pegau@oce.orst.edu
Award #: N000149710383

LONG-TERM GOALS

The long-term goal of this program is to investigate the affects of the physical forcing mechanisms on the distributions of the inherent optical properties in the near-shore and littoral environments.

OBJECTIVES

The objectives of this study are to determine:

- the vertical variability in optical properties over time scales of a few minutes to 10 days,
- the affect of the total water depth on the optical variability,
- the portion of the optical variance associated with internal waves, tides, wave height and period, wind force mixing and biologically driven mixing,
- what forcing conditions cause the greatest optical variability.

APPROACH

Our approach has been to combine field observations with analysis and theory. The Littoral Optics Experiment (LOE) was conducted in shallow water off Oceanside, CA from October 15 - 27, 1995. Hydrographic and optical properties of the water were measured simultaneously from the SlowDROP (Slow Descent Rate Optical Platform) instrument platform with a CTD and an ac-9. The survey was conducted at 18 stations within a square box of side length 3 km. This data has been processed and basic statistical analysis has been performed.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**
4. TITLE AND SUBTITLE **Variability of Optical Properties Within the Littoral Environment**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Oregon State University,College of Oceanic and Atmospheric Sciences,104 Ocean Admin. Bldg.,Corvallis,OR,97331**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR’S ACRONYM(S)
		11. SPONSOR/MONITOR’S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**5**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Dr. Weidemann and Dr. Johnson were involved in collecting moored time series of hydrographic and optical data during the cruise, and they also have ac-9 measurements made from another vessel. Remotely sensed images of the survey area were also made during the last three days of the experiment.

WORK COMPLETED

We have processed the 600 plus profiles that were made during the LOE. Kieran O'Driscoll and Dr. W. Scott Pegau have completed a basic statistical analysis of these profiles.

We have worked with Dr. Weidemann and Dr. Johnson of NRL/Stennis Space Center to present and compare our respective data sets. It is obvious that physical processes appearing in our data set are also present in their data set.

RESULTS

Observations of the density field reveal a water column that is normally well stratified below 15 m and water that may be either well mixed or stratified in shallower water. The presence of internal waves is evident throughout much of the data set and their effect on the optical field is self-evident (O'Driscoll, et. al., 1997; Weidemann, et. al., 1996; 1997). Figure 1 shows the existence of three layers of high c(532), the uppermost layer being a biological layer, the central layer an intermediate nepheloid layer and the bottom layer a bottom nepheloid layer. The fact that the vertical movement of c(532) with time is removed along isopycnals reveals the gradient of c(532) is across surfaces of constant density. Shallow water supports the same density and optical gradients at different times during the experiment and the gradient of c(532) oscillates vertically with the density field (O'Driscoll, et. al., 1997). Observation of the profiles at the Optical Mooring(OM) on October 21st show that the density gradient can support the gradient in c(532) for periods longer than the time required to make three profiles.

Figure 2 at OS6 (Optical Site 6) shows the existence of a 5 m bottom mixed layer in 25 m water. OS3 (Optical Site 3) is the station directly offshore from OS6, and the intermediate nepheloid layer present here reveals strong evidence for the existence of convection currents in an offshore direction. This interesting phenomenon has been a topic of interest for the past several years and continues to be addressed by many investigators, e.g. Salmun and Phillips (1992), Garrett (1991). These investigators suggest that internal waves incident on a sloping bottom are an important source of energy for the resultant convective currents.

Several of the profiles give evidence for active overturning and mixing events. These profiles show that the density decreases with depth and therefore cannot be stable. These profiles are characteristic of the classic K-H (Kelvin-Helmholtz) instability. Several authors, e.g. Turner (1973), Thorpe (1987), discuss the K-H instability. The interesting and exciting aspect of these profiles is that c(532) have the same characteristics as the density profiles; i.e. c(532) gradients matching density gradients.

IMPACT/IMPLICATIONS

By continuing this analysis we plan to get a solid understanding of the dynamics of the internal wave field in this shallow water region, and also understanding the subsequent dynamical processes and how all of these events affect the inherent optical properties. With these tools in hand, we will have the ability to analyze remotely sensed images in shallow water environments and be able to predict and understand the characteristics of these internal wave packets and bores.

Resuspended sediments create false bottoms for optical bathymetry and understanding the dynamical-optical interactions will help us to differentiate between real and false bottoms and may provide information on the optimal conditions for operating optical systems in the near-shore environment.

TRANSITIONS

Dr. Weidemann at NRL is evaluating the remotely sensed images at the site. Dr. Johnson at NRL is evaluating current and tidal time series at the site.

RELATED PROJECTS

We have been sponsored to work in the CMO project. Hydrographic-optical interactions in the deep-shelf region can help us to understand similar interactions in the near-shore environment. Spectral signatures from COPE will supplement our spectral signature understanding in shallow water. Both projects have been funded by ONR.

REFERENCES

O'Driscoll, K., W.S. Pegau, and T.M. Dillon, 1997, The variation and dependence of optical properties on high frequency internal waves in a near-shore environment, EPOC, 1997.

Garrett, C. 1991. Marginal Mixing Theories. *Atmosphere-Ocean* **29(2)**, 313-339.

Salmun, H. and O.M. Phillips. 1992. An experiment on boundary mixing. Part 2 The slope dependence at small angles. *J. Fluid. Mech.* **240,** 355-377**.**

Thorpe, S. 1987. Transitional phenomena and the development of turbulence in stratified fluids: a review. *J. Geophys. Res.* **92,** 5231-5248.

Turner, J.S. 1973. Buoyancy Effects in Fluids. *Cambridge University Press*, pp367.

Weidemann, A.D., W.S. Pegau, L.A. Jugan, and T.E. Bowers, 1996, Tidal influences on optical variability in shallow water, SPIE Ocean Optics XIII, Halifax, Canada.

Weidemann, A.D., W.S. Pegau, and L.A. Jugan, 1997, The influence of internal waves on coastal optical properties, ASLO meeting, Santa Fe, NM.

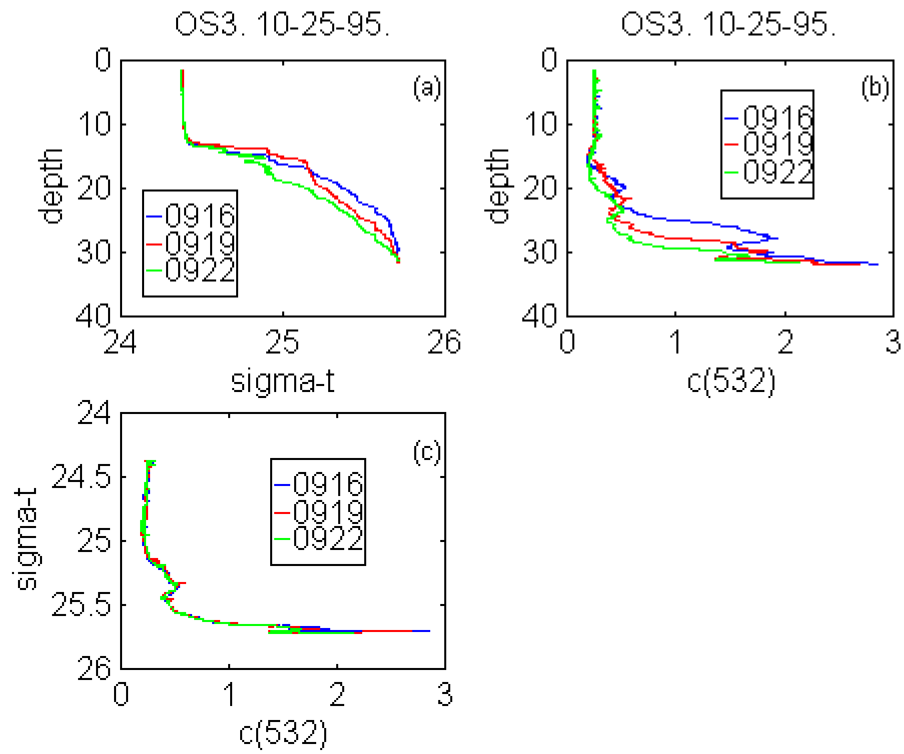

Figure 1 shows a series of 3 profiles made at OS3(Optical Site 3), the offshore station on the central transect. The profiles were made from 0916-0922 local time. Figure 1a. is a plot of density v. depth. The upper mixed layer is about 12m deep and the bottom mixed layer is about 2m deep. The region in between is stratified and we can see the rapid vertical movement of the isopycnals. Figure 1b. is a plot of c(532) v. depth, where c(532) is approximately the total concentration of suspended matter in the water. Figure 1 shows the existence of three layers of high c(532), the uppermost layer being a biological layer, the central layer an intermediate nepheloid layer and the bottom layer a bottom nepheloid layer. Figure 1c. is a plot of c(532) v. density. Figure 1c. shows that c(532) is constant along isopycnals thereby revealing that the vertical movement of the gradient in c(532) is due to the oscillation of internal waves.

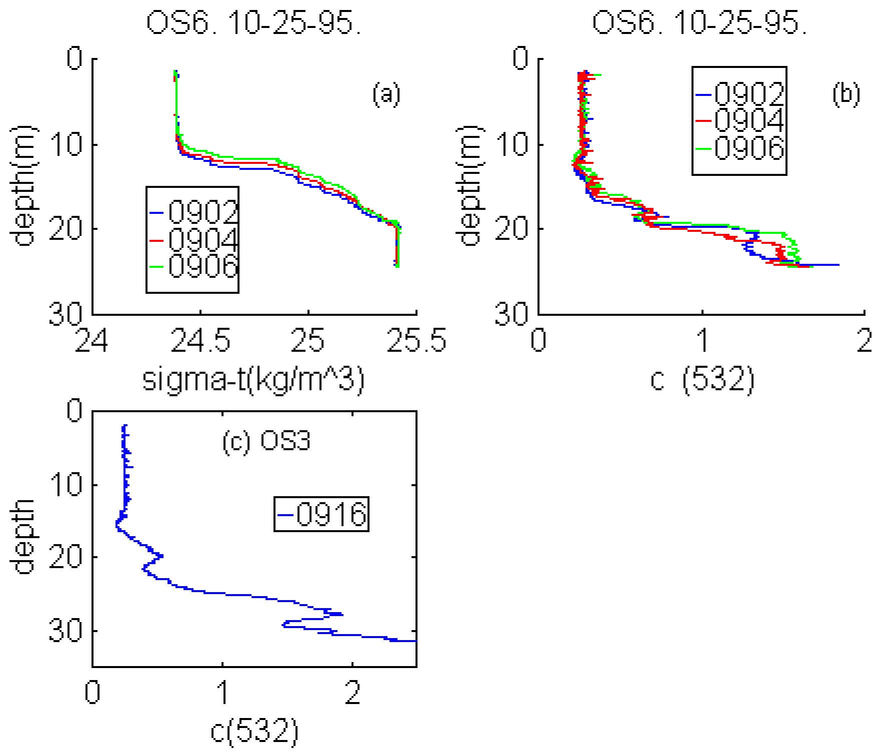

Figure 2. Figure 2a is a plot of density v. depth. There is a 5m bottom mixed layer. Figure 2b. is a plot of c(532) v. depth and shows the existence of a bottom nepheloid layer of similar magnitude. Figure 2c. is a plot of c(532) at OS3 made 10 minutes after the profiles at OS6.